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THE IMPACT OF CLIMATE AND WATER RESOURCES ON THE ENVIRONMENT

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Climate and water resources are very basic components of the physical environment Exploitation of these needs conservation, so the environment effects man and man effects the environments. This study has led to various theories such as environmentalism, Determinism and Possibilism in the geographical school of thought in Germany and France. As we all know the environment can be classified as N Natural environment and cultural environment or otherwise it can be termed physical environment and Man-made environment. Generally physical environment provides resources of agricultural land, climate, water, minerals etc. The relationship that exists between the occupants of the earth and their physical world determines their use. It decides the degrees of environmental effects. Individuals and groups directly affect the physical environment through their utilization of resources. We can find many constraints in the environment. These constraints are relative to capabilities to manage our wants and demands within the scope of available technologies. Physical constraints of finite quantities of fertile land, petroleum, coal or water do not mean absolute limits, ratherthey are relative to human wisdom and ingenuity. Whether 1 billionpeople enjoy wealth while 4 billion people suffer poverty or all 5 billion people experience a relatively high standard of living depends on the technology and management of agricultural, Industrial and other resources necessary for the livelihood of the human population (Jackson H. Richardand Hudman. E. Lloyd)

During the past , under - development was blamed on the physical environment and particularly on the climate of the less developed regions of the world that in some way prevented their occupants from progressing economically. More recent observers have concluded that the cause of under -development is the cultural values of the residents of the regions. The culture determines the level of development and societies can be classified in terms of their social, political and technological organizations.

But, the relationship between the human population and the environment is more complex that either of these simplisistic views allows. Physical and cultural variable decide how people arrive at certain decisions. The relationship between environment and people is based on the perception of the residents of a place. The way in which people perceive the environment isin turn affected by their technology, their goals, their cultural background andexternal forces that affect the group. The diagram 01 explains the relationship between the environment and man,

However the availability of water is the basic component in the physical environment for the existence of human life and reacts on the environment. Water can be received directly from rainfall or surface water resoures or underground water resoures. In Sri Lanka climate and water resoures have mostly a favourite impact But in the northern Sri Lanka, specially in Jaffna peninsula even the climate is not so favour able but the underground water resoures are attractive.

CLIMATE IN THE ENVIRONMENT

Sri lanka's tropical location provides a better climate. Due to the influence of the sea the Island is free from the temperature extremes expended by continental interiors and extreme climate. The climate of the Island is in influenced by two wind regimes. The South-west monsoon is from May to September and Northeast monsoon is from December to February. These monsoons control not only the rainfall of the Island but also control the rainfall of South Asia during the respective periods. The impact of the monsoons is decided by the orographic environment of the Island. The Central massif creates this effect. In between these two seasons there are two inter monsoonal seasons, March to April and October to November, in which mainly convectional rainfall occurs. During October to November, sometimes to December the Island is also influenced by depressions and cyclones which form particularly in the Southwest Bay of Bengal and Southeast Arabian Sea. Mean annual temperature in the lowlands are around 27'C with mean daily range of about 6°c ground cost can occur in Nuwara-Eliya when the mean annual temperature is 15'C In most part of the country daily temperature range are more signifacant than the seasonal change.

(Fig: 1 a, b, c, d)

1.1 SOUTH WEST MONSOON (MAY TO SEPTEMBER)

The southwest region of the Island receives more rainfall upto 4000 m in this period. The Higher rainfalls are over the western slopes of the central hills. The rest of the Island receives less than 500mm of rain and particularly our part, North and Northwest regions receive less than 250 mm of rain. The South west monsoonal rainfall creates a rainfall region in the southwest and shadow rainfall region in the North, northwest, North east and East of the country due to the central mountain and this creates two major regions such as Wetzone and Dryzone which are the main agro-climatological regions If Northern Sri Lanka had been blessed with a mountain range in the northern coast this area also would have more rainfall due to the orographic effect in this season. Generally winds prevail westerly over the Island. But at the sea level the winds are from the southwest. The pressure gradient is fairly steep and southwesterly.

.2 NORTH EAST MONSOON (DECEMBER TO FEBRUARY)

During this period the easterly winds prevail across the Island with the winds tending to be northeasterly at the sea level. The rainfall during this period is fairly widespread but the eastern half of the Island receive more. The area that receives less than 250mm. of rain during the Northeast Monsoon is very much less than the area receiving a similar amount during the Southwest monsoon. The pressure gradient across the Island is moderate and northerly. Fig: 2

1.3 FIRST INTERMONSOONAL PERIOD (MARCH TO APRIL)

The rainfall is mainly convectional and ranges from 5% to 30% of the annual rainfall. The higer contribution to the total annual rainfall are from Inland araes. The lower contributions are from the north where Kankesanthurai receives 6% of the annual. The presssure distribution is fairly even or pressure gradient is mild and southwesterly. Fig: 2

1.4 SECOND INTERMONSOONAL PERIOD (OCT - NOVEMBER)

During the period, the rainfall is widspread due to the low-pressure systems, depressions and cyclones in the southwest of Bay of Bengal and the South Arabian sea. These disturbances generally form Intertropical convergence zone which lies acros the latitudes of Sri Lanka during October and November. The rainfall varies from 17% to 31% of the annual total. The Northern reginn receives more in this season, But the Eastern region receive more during the North east Monsoon season particularly in December. The pressure gradient is mild and south westerly or pressure distribution is fairly even. Fig: 2

1. 5. INTER TROPICAL CONVERGENCE ZONE

This zone of convergence takes place between the trades called the Inter tropical convergence zone (ITCZ) and, has influence in our weather during the intermonsoonal periods. During the Southern hemisphere summer the ITCZ lies between latitudes 5°c and and 10°c but during the northern hemisphere summer it moves northwards and lies over 25° c and 29°c over North India. The ITCZ is often an area of large scale convetion activity and heavy rain. When it travels southwards and northwards we have more rain in intermonsoonal periode, sometime it may be fluctuate.

1.6 CYCLONIC STORMS AND DEPRESSIONS

Mainly in October, November and December cyclonic storms and depressions form over the southern half of the Bay of Bengal. Rarely they develop in May & June also. The chance of a cyclonic storm coming directly over Sri Lnaka is greatest in November and December. The average number of depressions per decade is 16 in October, 12 in November and 6 in December. The average number of storms per decade is 8 in October, 8 in November and 4 in December. The cyclonic activity

creates floods in some years, droughts in some years and hazards in a few years,

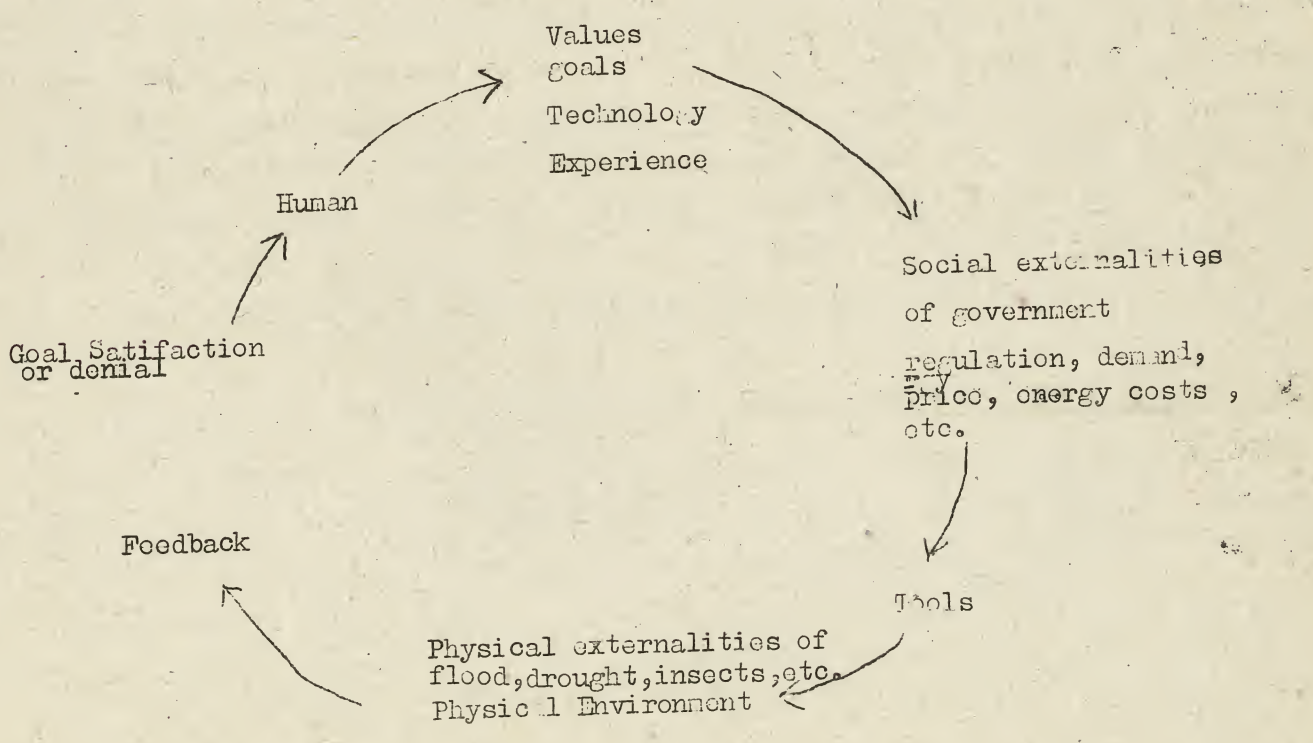
1.7 DRY ZONE / WET ZONE

The climate created the northern region as a three months rainfall region. Towards East and South and Southwest the rainfall months increase. In the wet zone there are two distinct rainfall seasons that prevail. According to seasonality of climate and the water balance there are two climatological zones in the Island. The following were used to demarcate the zones by various academics.

1. The 1500 mm Isohyet of annual rainfall.
2. The 1905 mm Isohyet of annual rainfall.
3. The 2500 mm Isohyet of the annual rainfall.
4. The 508 mm Isohyet of the annual rainfall of the southwest monsoon season.
5. The watershed lines.
6. Wet zone where no water deficit prevails annually & seasonally.

The wet zone of the southwest and central hill country averages 2500 mm of rainfall mostly through the year, while the remaining two thirds of the country in the north, east and south east stay comparatively dry, averaging 1500 mm mostly is Maha season (Oct - Jan). It remains dry during the five months of the Yala season (may - Sept)

MODEL OF PERCEPTION OF ENVIRONMENT



Evapotranspiration

Data on evapotranspiration are limited. But estimates in the wet zone indicate annual evapotranspiration of approximately 1500 mm with an upper limit of 1200 mm. In the highest montane areas it declines to 1000 mm. In the Dry Zone and in the Wet Zone these values are the same in the Maha season. But in the Yala season lower rates are prevail in the Dry Zone. The annual value is 1000-1400 mm for Dry Zone. Evaporation values from Dry Zone tanks can reach 2100 mm/year.

1.8 Variability of rainfall

Annual variability of rainfall in the wetzone is about 10% and in the Dry Zone 15% and 20% in the east coast. Maha season rainfall is more variable than Yala season. Discharge is nearly absent in the dry years of 1934, 1946, 1951, 1955 and 1958.

1.9 Extreme climates

Floods, Droughts and cyclonic hazards have a disruptive effect on the normal climate. During the last century two drought years 1950 and 1974, and three flood years 1891, 1957 and 1963 affected 50% of the country. Cyclonic years 1947, 1958 & 1978 also disrupted the economic and social life in the country.

2.0 Water Resources in the Environment

Water resources are commenly classified as surface water resources and groundwater resources.

2.1 Surface water Resources

Water received from rainfall circulates in a continuous process of evaporation, Evapotranspiration and condensation and back into rainfall through the many environmental factors such as geology, topography, soil, vegetation and temperature. The crystalline rocks, common in Sri Lanka have low porosities about 02% to 0.8% so the rocks promote heavy runoff 65% for the wet zone and 37.5% for the dry zone. For the entire Island the balance of the surface water runoff is estimated at 53% available for evaporation, percolation and recharge of the water table.

There are 103 watersheds in Sri Lanka, there can be identified in the surface water resources map in which they are numbered anticlokwise from Kalani ganga. The Mahaweli basin dominates covering about 16% (10327 sq k.m.) of the Island's total land area and carries the largest volume of discharge amounting to a seventh of the Island's run-off. It is the only perennial river traversing the Northern Dryzone. High density of streams are in the humid interior, the cause for the high runoff. The streams in the Dry zone are seasonal and their seasonal runoff is less than that in the Wet Zone. So the importance of the surface water has been better understood by our hydraulic culture. Water resources in the physical environment provided maximum use for the development of economic and social life of the people throughout our history.

Based on surface water resources irrigation schemes and river valley development schemes have been started. At present there are 521 major irrigation schemes of which 307 are storage schemes, 104 are diversion schemes, while 110 are drainage, flood control or salt water exclusion schemes. In addition there are 12 lift irrigation schemes in operation. All these schemes have an extent of about 340,000 hectares. Further, there are nearly 25,000 minor schemes which cover an extent of about 162,000 hectares. (Minor schemes< 40 hectares>Major schemes) Largest irrigation schemes such as Mahaweli Multi purpose Programme is in operation. The programme will provide irrigation facilities for 265,000 ha of new land and 100,000 ha of existing land at the end. All are based on river basins (Fig:3).

2.2 Ground Water Resources

The geological Formation that largely determines Sri Lanka's aquifer characteristics can be grouped into four categories.

1. Ancient crystalline hard rocks spread over 90% of the land. These precambrian rocks have poor primary porosities and their ground water is often found in their joints, fissures and cracks.

2. Sedimentary formation, that characterize most remaining areas which include Miocene limestone areas of the North and North West.

3. Surface Alluvium, consisting of clays, sands and gravels in the riverrine and coastal areas; and

4. Weathered over-burden in hard-rock areas which includes products of weathering such as soil and gravelly material that form localized aquifers.

Rates of ground water recharge from rainfall vary one geological formation from another. Underground water resources in the North and North west regions are different from the others.

2.3 Under Ground Water Resources in the North and Northwest Regions

The North western region of limestone origin has underground water as nature's gift. This area is the driest in terms of climate and has rainfall in three months, and has good environment by means of water. Early settlers had discovered the resources of underground water and made settlements where good underground water has been found since 500 B.C. This can be classified according to the aquifer found in the limestone rocks as follow:

1. Local or discontinuous productive aquifer in intogranular rock.
2. Extensive and highly productive aquifer.
3. Local or discontinuous productive aquifer in fissured rock.
4. Local or discontinuous moderate to low aquifer in frackmanted rock.
5. Lagoon or lake with saline or blackish water.

2.3.1 Local or Discontinuous aquifer

This type of aquifer is found in the eastern coasts of Jaffna peninsula, the Island of Mannar, Kalpitty and in the interior areas next to the extensive productive and discontinuous aquifer resources (Fig.).

2.3.2 Extensive and Highly productive aquifer regions

The extensive and highly productive aquifers in the sedimentary limestone extends from Puttalam to Jaffna Peninsula and inwards to Kilinochchi and Mullaitivu. Tube wells constructed in the main land area are used mainly for irrigation. The depth of wells range from 30m to 100m and the depth of the water table varies from 5m to 15m. The ground water in this region has a moderate to high concentration of cholorido.

The total extent of this aquifer covers about 10% of the Island's land area and this can be classified as the following rich basins.

a. Madurankuli ground water Basin
b. Vanathavillu ground water Basin
c. Kondaichi ground water Basin
d. Mannar-Murunkan ground water Basin
e. Mulankavil ground water Basin
f. Kilinochchi-Mullaitivu Basin
g. Jaffna peninsula ground water Basin

The Madurankuli ground water basin is in the far south in the underground water belt. In the Vanathavillu basin, which spreads over 40 sq.km. the confined aquifer creates artesian conditions. Between 5-20 million cubic waters could be available annually at Vanathavillu.

At Murunkan deep-tube well technology has developed over the last fifteen years to supply water for irrigation and domestic use. A relatively high yielding semi-confined aquifer system has been found there from 15-20 meters below ground.

The next major system has been found at Mulankavil Basin, covering 180 sq.kms. Average yields from tube wells there range from 15-35 litres per second.

In the Jaffna basin, ground water use has exceeded safe limits in most areas where sustainable irrigation depends on maintaining a delicate balance between recharge and extraction. The use of ground water in Sri Lanka is normally confined to domestic purposes, the notable exception being the Jaffna peninsula when it is used extensively for irrigated agriculture from a network of wells. Covering 850 sq km, the peninsula exhibits lenses of ground water in most places except the lagoons. Valigamam, Tenmaradchi and Vadamaradchi are important extensive and highly productive areas.

2.3.3 Other acquifers in the North west

Local discontinuous productive in fissured rock acquifer is found in the Islands west of the Jaffna peninsula and in between areas of so called rich ground water basins. Discontinuous moderate to low acquifer in fractured rock is found in the high level areas in the main land. Saline or brackish water is found in the areas close to the sea and lagoons.

3.0 : Rainfall and Water Resources in the Jaffna environments

Climatologically the Jaffna peninsula belong to the three effective month period of rainfall. The following table explains the fact clearly.

Jaffna

Average Monthly & seasonal Rainfall in mm(") 1931-1960

Dec.	266.7			
Jan.	96.5	400.0	30.1	+ 30.1
Feb.	36.8			
Mar.	29.9	100.0	7.5%	
April	70.1	Inter monsoonal (convectional) ITCZ		
May	62.7			
June	16.2			
July	16.5	174.2	13.1%	
Augu.	31.4	(South west Monsoonal)		
Sept.	47.4			
Oct.	243.5	654.7	49.3%	+ 49.3 = 79.4
Nov.	411.2	Inter monsoonal (Depressions & storms) Convectional ITCZ		

Total: 1328.9 mm.

During the cyclonic period the area receives 49% and during the North east monsoon period it receives 30% of the average annual rainfall. The figures show that the monthly rainfall for October, November and December had fluctuated during the fifty years of the period (1921-1970). During the October months of 1930, 1932, 1942, 1946, 1962 & 1965 it received more than the average. But in some years 1931, 1937, 1961, & 1968 very much less amounts of rainfall were received. Likewise this was noticed in the months of November & December. For example in November 1932 more than 30" received. It was double of the average rainfall. During the November month of 1925, 1927, 1931, 1934, 1941, 1944, 1946, 1957, 1970 it received more than the average. But in some years 1922, 1941,1947 a very less amount was received. During the December months of 1931 & 1957 nearly 30" received. In these months also a few years received more than the average. The December months of 1921, 1922, 1930, 1958, 1960, 1970 received very less amounts. The January month receives less rainfall compared to the other wet months however these months also depict same pattern. The frequency diagrams show the amount received so frequently in the respective months during the period. (Figs 4, 5, 6 & 7 a & bs.)

Jaffna

Potential Evapotranspiration (Estimates) and water balance (in mm)

	PET	Water Balance
January	105	-10
February	115	-39
March	149	-69
April	150	-123
May	167	-155
June	129	-152
July	127	-152
August	118	-134
September	129	-93
October	108	0
November	87	147
December	78	129

The estimates for potential evapotranspiration show only slight deviations in the dry months. Water balance figures show that a water balance exists in October only and Water surplus exist in Nov & Dec. In the other months, particularly from April to Sept there are water deficits. These are the outcome of rainfall. The water needs for agricultural and domestic purposes in the deficit months are met by the underground water.

3.1 Underground water, usage & Vertical distribution of salinity

The studies made in 1960's and in 1980's reveal the underground water situations in the Jaffna peninsula. Due to the intensive use, the run off of underground water for various purposes are forecasted as follows;

	1965/66	1966/67	1965, 66, 67
Areas free from salinity	128,100	142730	145,000
Areas moderately free from salinity	64,200	64000	60,350
Areas liable to salinity only in the dry season	46,480	43800	47,800
Saline areas	17,290	11000	12,450 in acres

The areas consistently free from salinity have increased by 13% and the areas moderately free from salinity have decreased by 6%. The areas liable to salinity only in the dry season have fluctuations in the coverage. The extent of saline areas has decreased. These depend on the storage, draw-off and discharge of the areas. During 1960's and 1970's the extraction of water was increased by the introduction of electrical pumps and the new crops. But in the latter part of 1980's it decreased due to the political situation. When there was high rainfall, the storage of water has increased and when there was low rainfall the storage was reduced. The public without a knowledge of the facts draw off the water without giving preference to the experienced drought year. The consumption in 1960's and 1970's for domestic and agricultural uses was estimated at 40,000 acre feet per annum. The recharge for a normal year (1966) is 90,000 acre feet, and discharge (runoff) to the sea is 50,000 acre feet. For a drought year these are not possible. In 1965 which was a drought year, 50,000 acre feet recharge was expectedand the runoff would have been under 10,000 acre feet. But the rate of consumption of water has not changed. In a flood year (1967), about 177,000 acre feet recharged and a 137,000 acre feet discharged to the sea directly and indirectly. A portion of recharged also would have gone to the sea due to the ground storage. The underground water free from salinity is situated in the centre of the peninsula where 62,600 acre feet are available but the drawoff was only 10,000 acre feet per annum. In the eastern part of the peninsula only 600 acre feet was drawoff out of 70,000 acre feet. But in the Islands where 12,000 acre feet available, the drawoff was 3300 acre feet per annum. So extraction of underground water could be increased in the centre and the east of the Jaffna peninsula. (Fig: 8)

4.0 CONCLUSION

The earth summit held in Rio de janeiro is over and the north - South Dialogue regarding the declarations made on the summit have not received global attontion. Industrializaed nations due to their rapid industrialazation in the past have already spoiled the environment and tend to tell third world countries that there will be a collapse of the environment system because of global warming, changes in the green house effect, increases of gases such as CO_2 chloro fluoro carbon in the atmos phere, ho acidic rain and hole in the Ozone layer. But third world countries have not accepted those Even if these are true, They are keen to develop their countries. As a small nation we have done nothing to spoil the earth - atmostphere system. But we have to learn to adapt economic or social activities in relation to the environment system such as climate and water resoures. In the greater p part of the dry zone. conservation of surface water resources has been developed. The ; of natural ve etation, soil cover climate have not been considered there pollution in the water Atmos phere have not been prevented there.

In the our part of the country the life has to be adjusted for environment at least in natural vegetations soil cover, parent rock, weather & climate and under ground water resoures. The climate has defined our agricultural activities for one season Even so we carry out agricultural practices for two season in some places for three season of subsidiary and cash crops depending on the under ground water. Therefore we have to concentrate on the rechargo of water and the control of run off during the raining season, we should also concentrate on the extraction and storage of water in the other season. we should not disturb our exsisting system of environment by creating salinity, air pollution, water pollution. Vegetational pollution.

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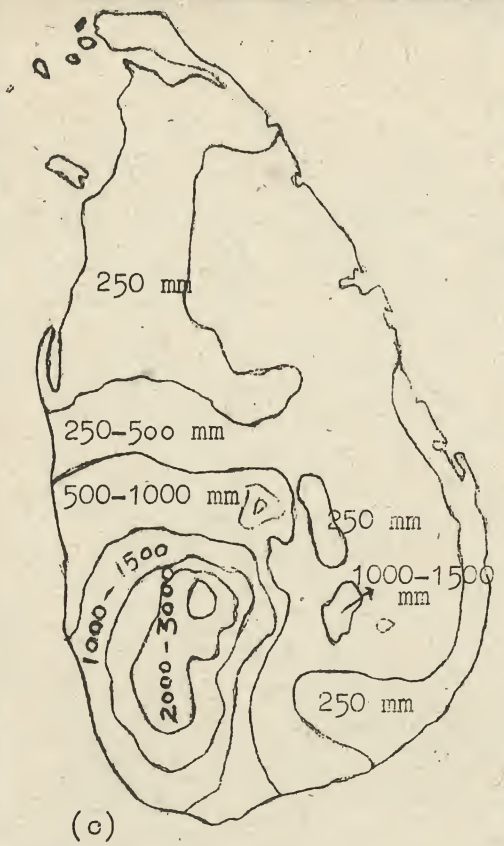
Fig: 1

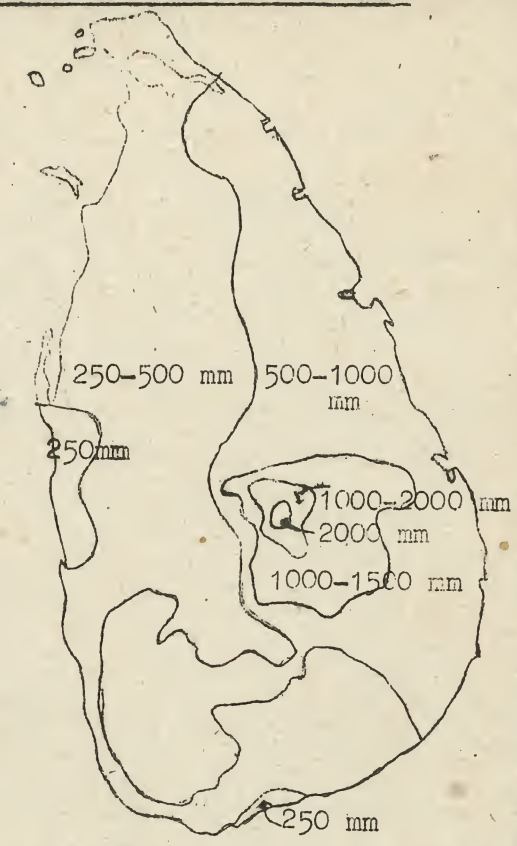
(a)

South-West Monsoon Rainfall



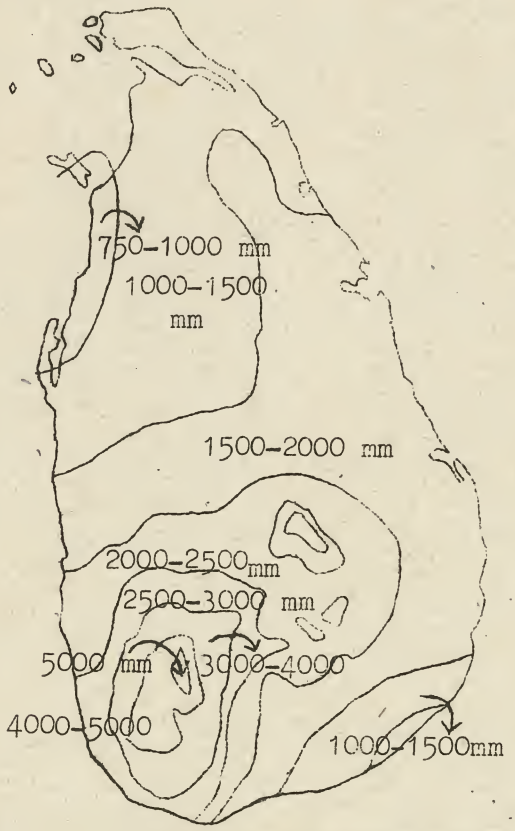
(b)

North-East Monsoon Rainfall



(c)

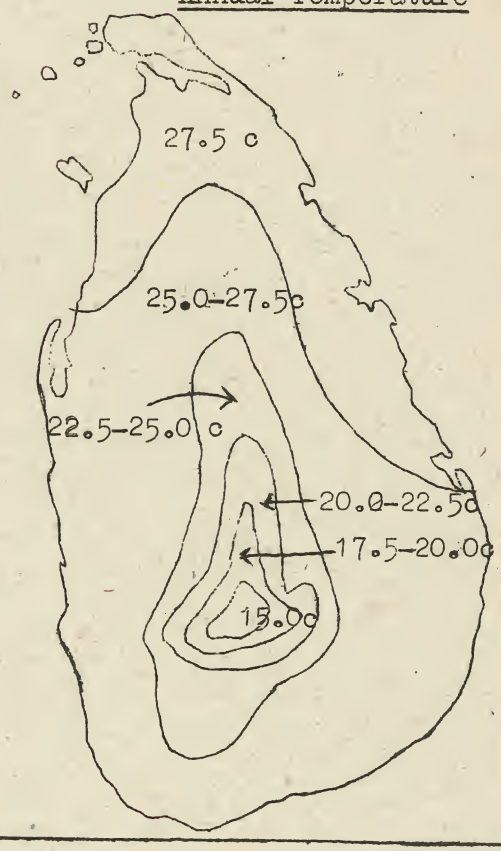
Annual Rainfall



Scale: 1cm=40km

(d)

Annual Temperature



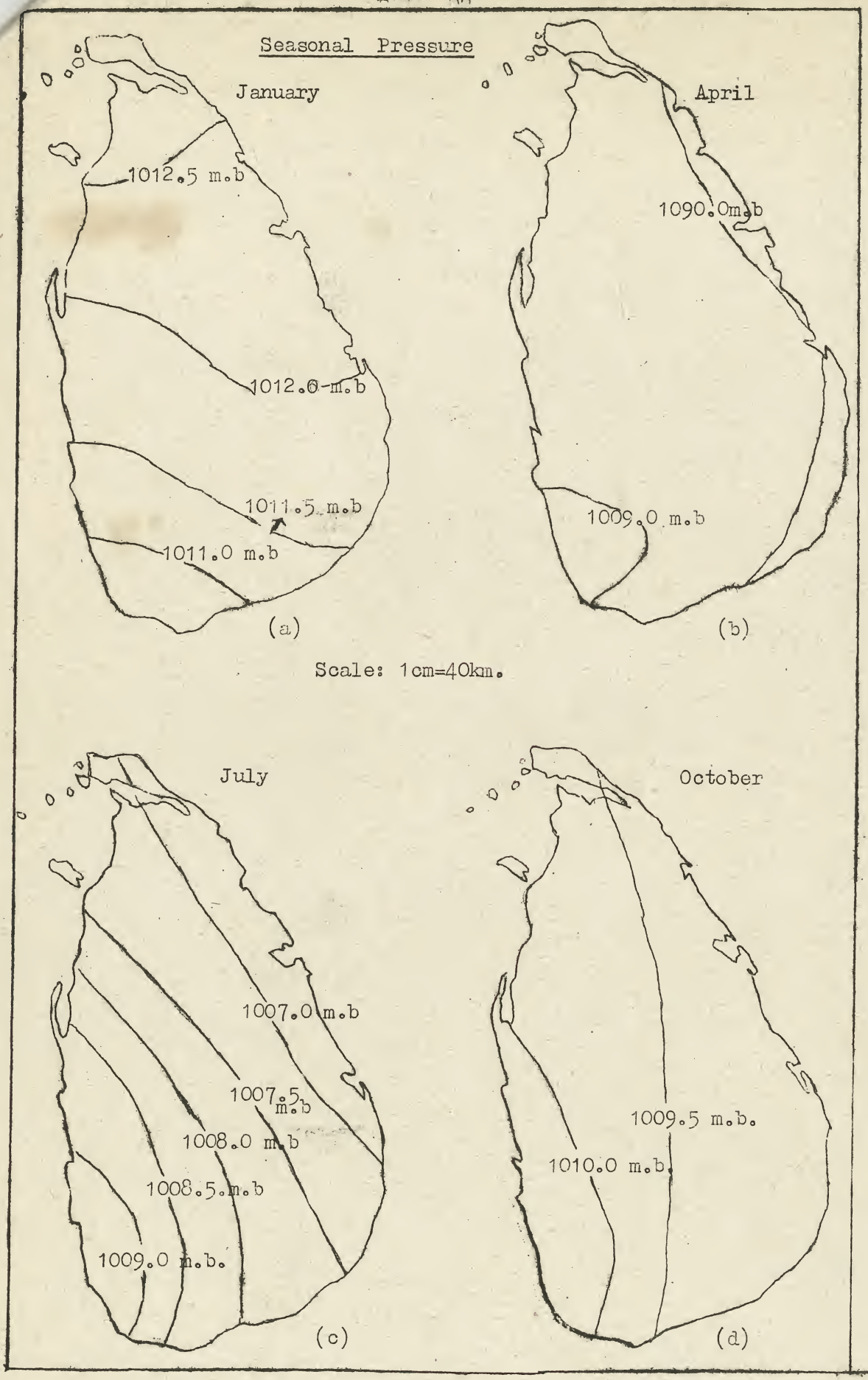
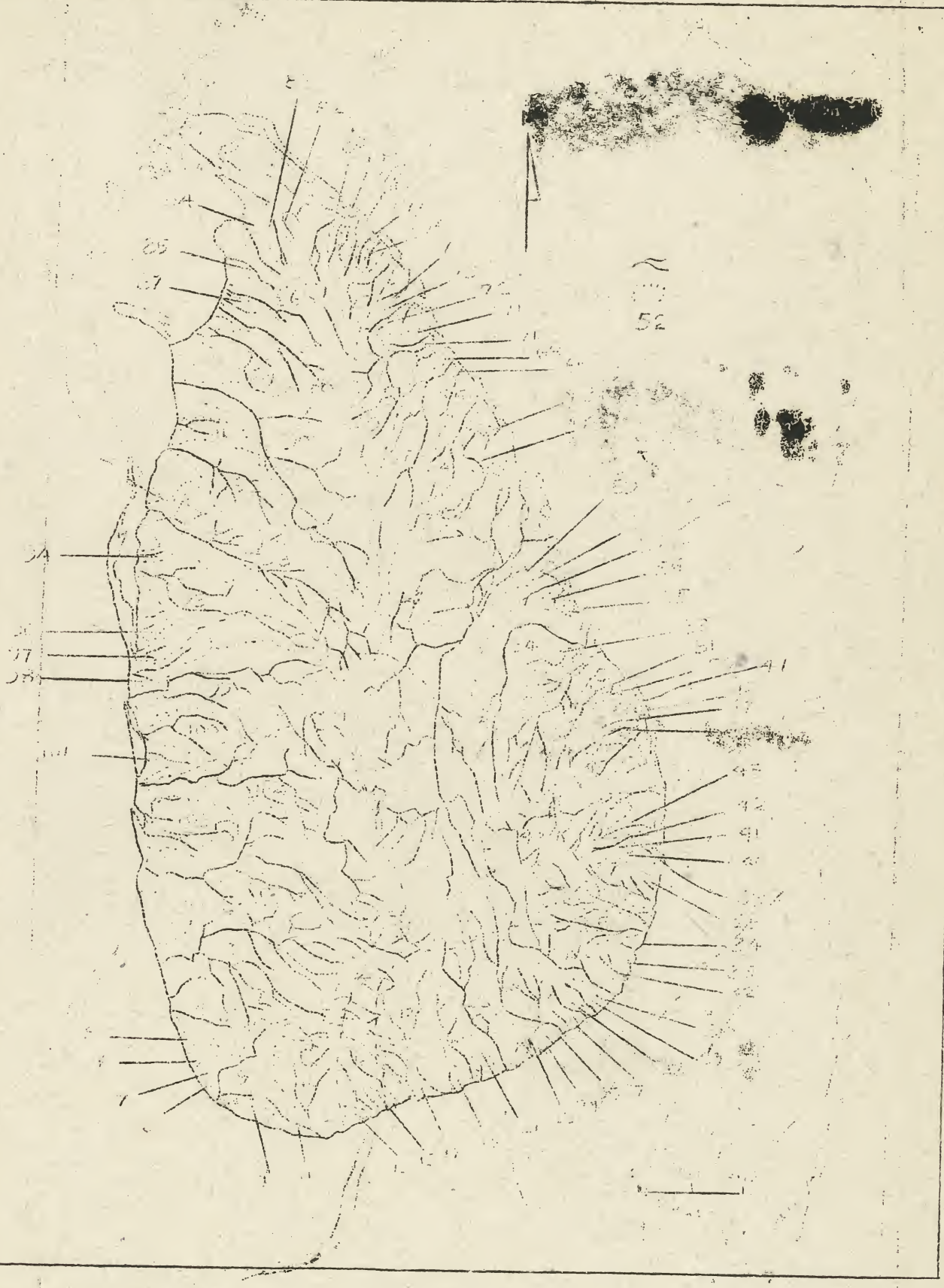
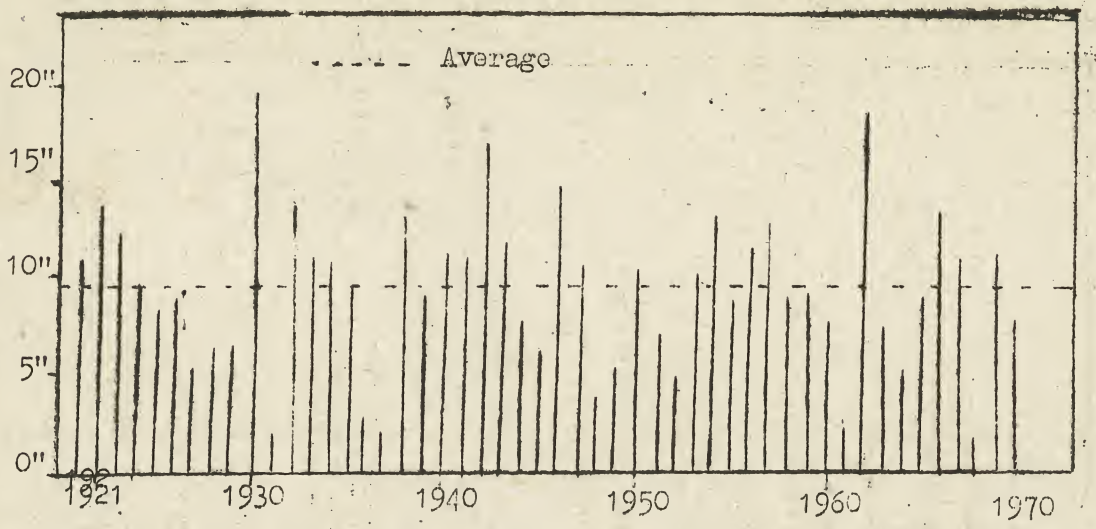

Seasonal Pressure
January
1012.5 m.b
1012.0 m.b
1011.5 m.b
1011.0 m.b
(a)
April
1090.0m.b
1009.0 m.b
(b)
Scale: 1cm=40km.
July
1007.0 m.b
1007.5 m.b
1008.0 m.b
1008.5 m.b
1009.0 m.b.
(c)
October
1009.5 m.b.
1010.0 m.b.
(d)

Fig 03

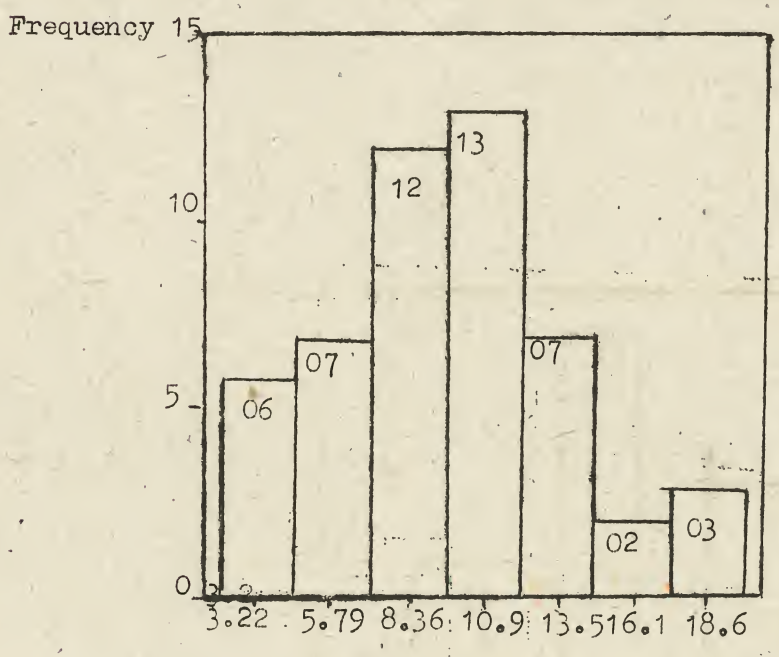
River Basins of Sri Lanka



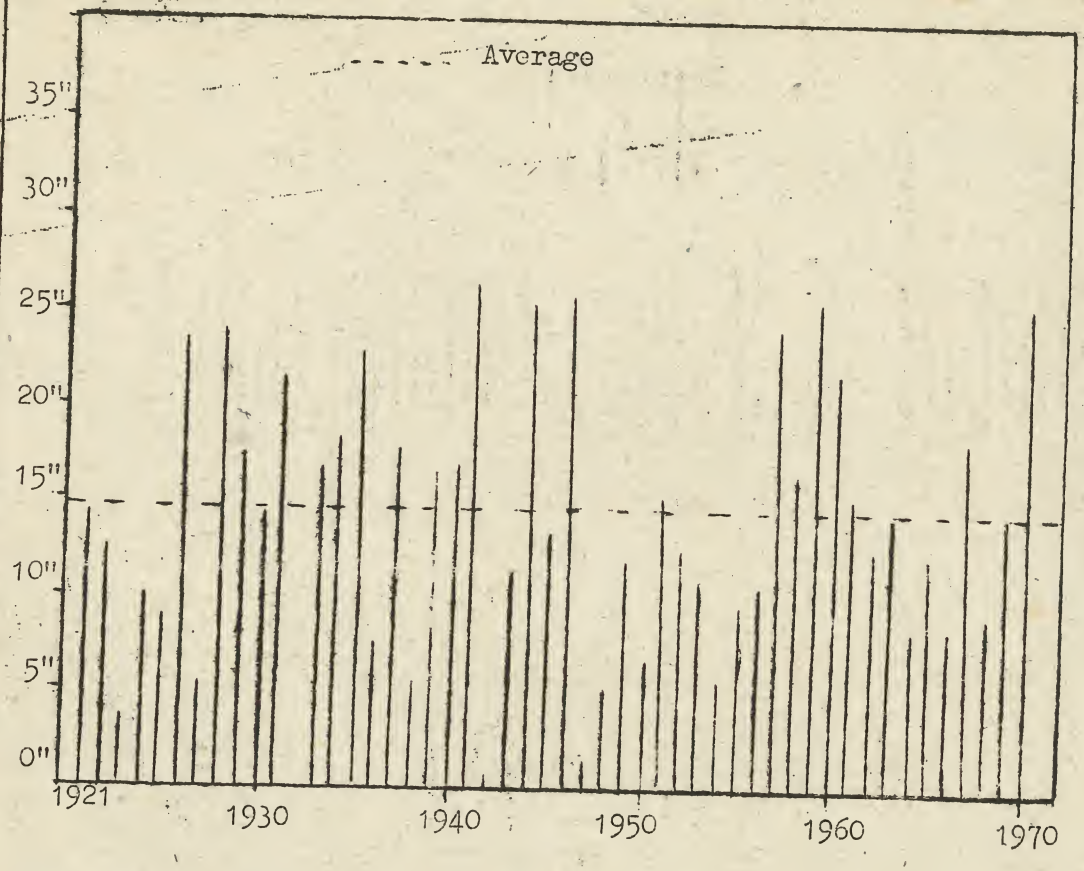
a. Rainfall of October Months (1921-1970)



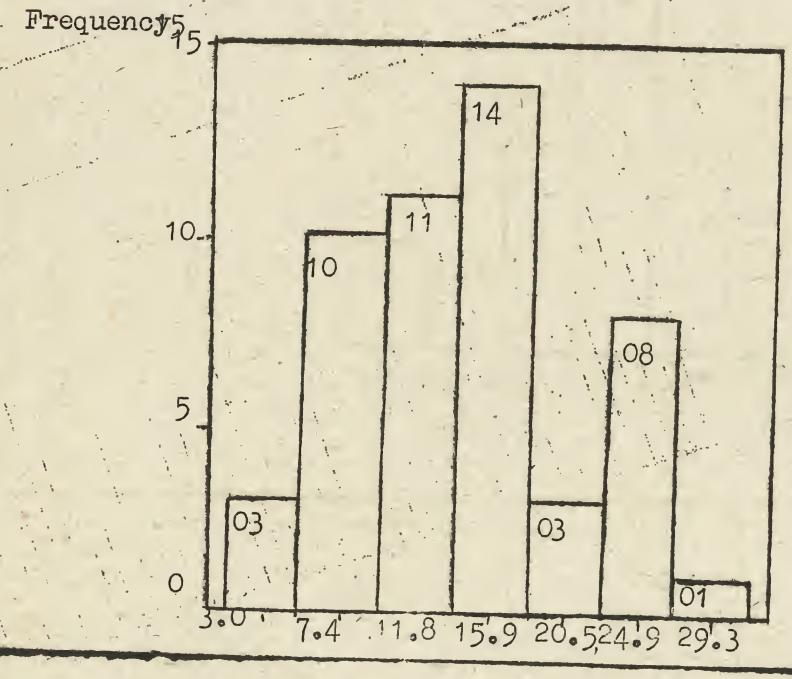
b. Rainfall Frequency of October Months



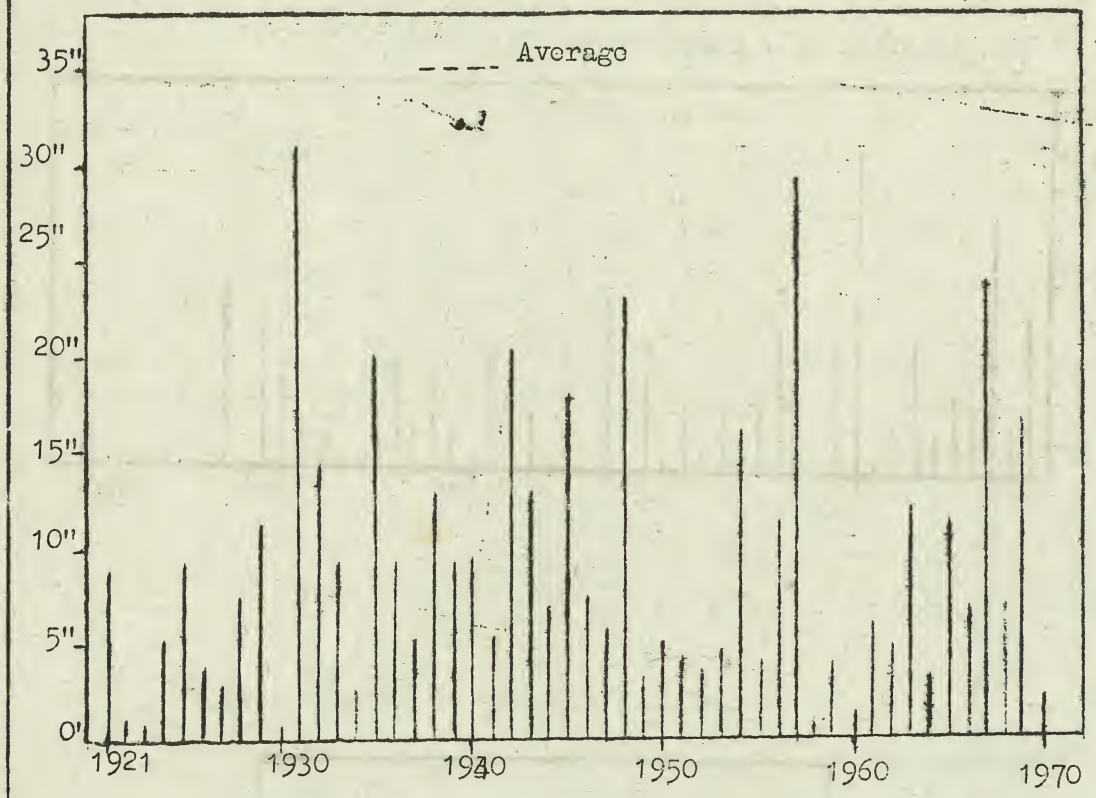
a. Rainfall of November Months (1921-1970)



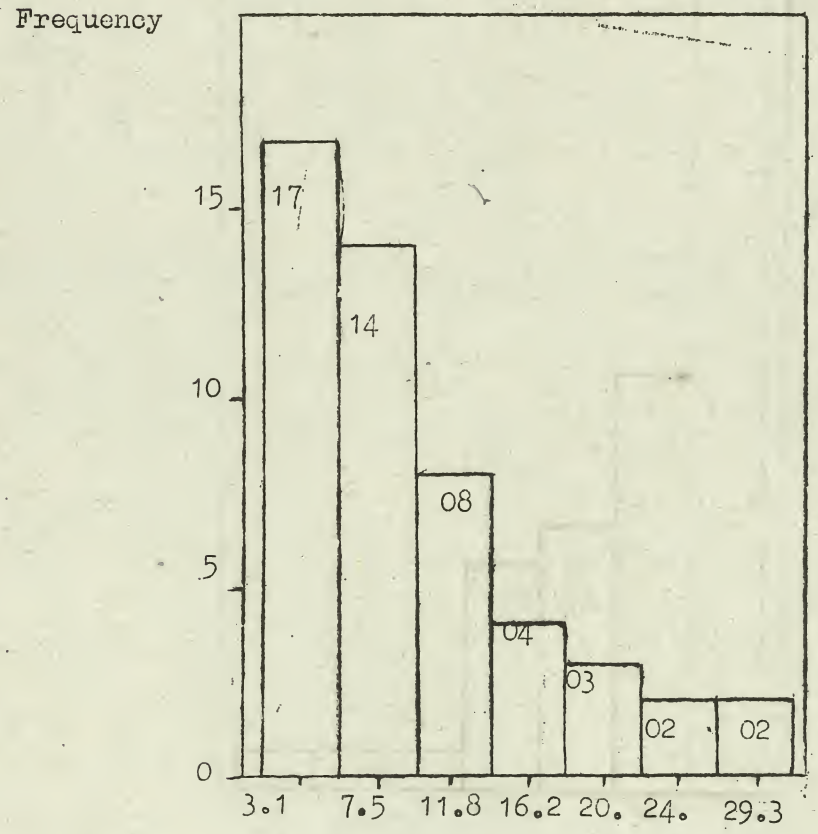
b. Rainfall frequency of November Months



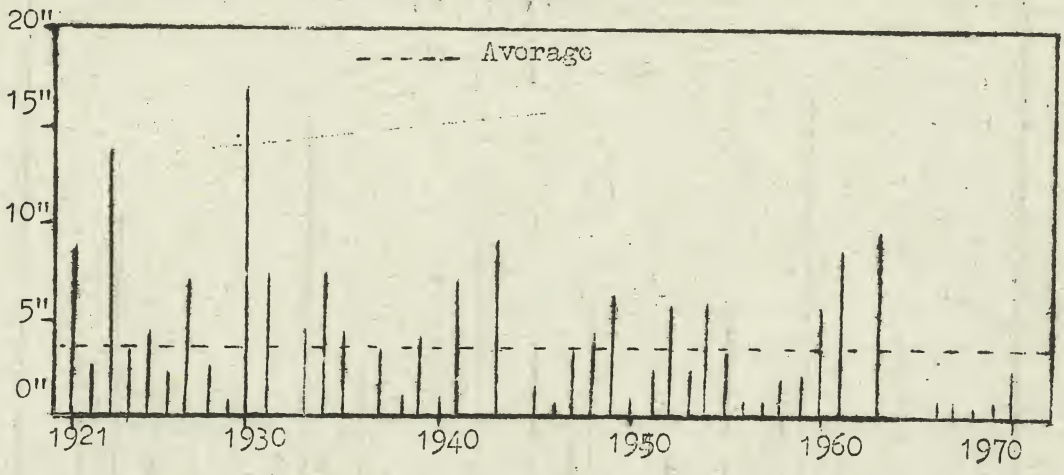
a. Rainfall of December Months (1921-1970)



b. Rainfall frequency of December Months.



a. Rainfall of January Months



b. Rainfall frequency of January Months

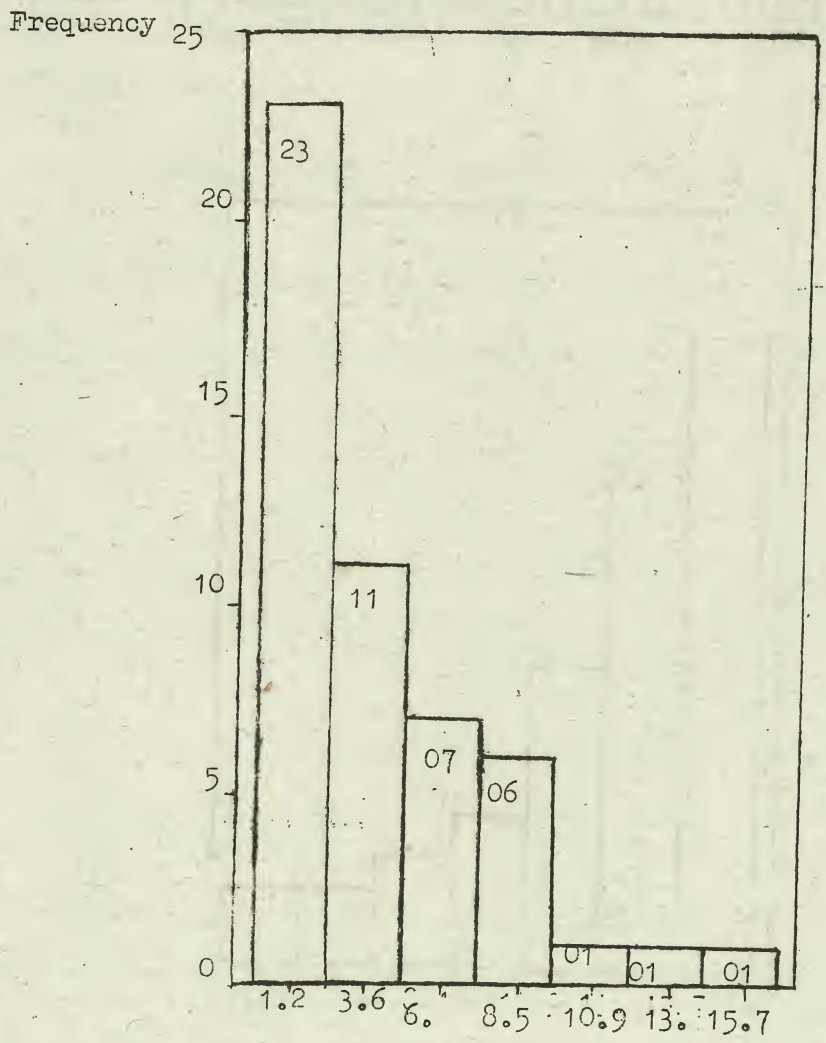
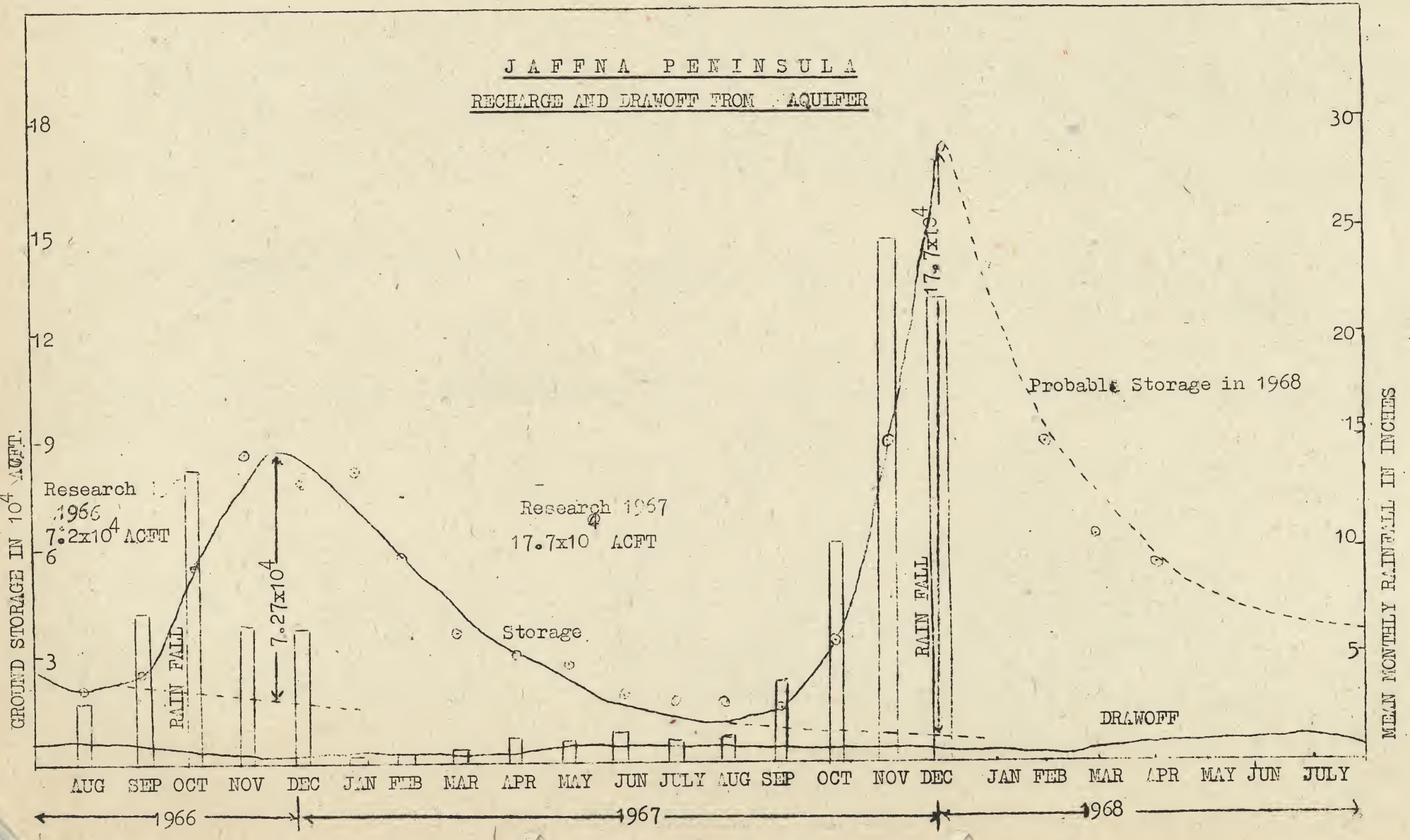


Fig: 08


JAFFNA PENINSULA
RECHARGE AND DRAWOFF FROM AQUIFER
GROUND STORAGE IN 10^4 ACFT.
MEAN MONTHLY RAINFALL IN INCHES
Research 1966
7.2×10^4 ACFT
Research 1967
17.0×10^4 ACFT
7.27×10^4
17.7×10^4
Storage
RAIN FALL
RAIN FALL
Probable Storage in 1968
DRAWOFF
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JULY AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JULY
1966
1967
1968

RIVER BASINS

Basin No.	Name of Basin	Catchment Area Sq.Km.	Basin No.	Name of Basin	Catchment Area Sq.Km.
1.	Kelani Ganga	2278	53.	Miyangolla Ela	225
2.	Bolgoda Lake	374	54.	Maduru Oya	1541
3.	Kaluganga	2688	55.	Pulliyanpotha Aru	52
4.	Bentota Ganga	6622	56.	Kirimechi Odai	77
5.	Madu Ganga	59	57.	Bodigoda Aru	164
6.	Madampe Lake	90	58.	Mandan Aru	13
7.	Telwatte Ganga	51	59.	Makarachchi Aru	37
8.	Ratgama Lake	10	60.	Mahaweli Ganga	10327
9.	Gin Ganga	922	61.	Kantalai Basin per Aru	445
10.	Koggala Lake	64	62.	Panna Oya	69
11.	Polwatta Ganga	233	63.	Palampotta Aru	143
12.	Nilwala Ganga	960	64.	Pamkulam Aru	382
13.	Sinimodara Oya	38	65.	Kanchikamban Aru	205
14.	Kirama Oya	223	66.	Palakutti Aru	20
15.	Rekawa Oya	755	67.	Yan Oya	1520
16.	Uruhokke Oya	348	68.	Mee Oya	90
17.	Kachigala Aru	220	69.	Ma Oya	1024
18.	Walawe Ganga	2442	70.	Churian Aru	74
19.	Karagan Oya	58	71.	Chavar Aru	31
20.	Malala Oya	399	72.	Palladi Aru	61
21.	Embilikala Oya	59	73.	Nay Aru	187
22.	Kirindi Oya	1165	74.	Kodalikallu Aru	74
23.	Bambawa Aru	79	75.	Per Aru	374
24.	Mahasilawa Oya	13	76.	Pali Aru	84
25.	Butawa Oya	38	77.	Muruthapilly Aru	41
26.	Menik Ganga	1272	78.	Thoravil Aru	90
27.	Katupila Aru	86	79.	Piramenthal Aru	82
28.	Kuranda Aru	131	80.	Nethali Aru	120
29.	Namadagas Aru	46	81.	Kanakarayan Aru	986
30.	Karambe Aru	46	82.	Kalawalappu Aru	56
31.	Kumbukkan Oya	1218	83.	Pkkarayan Aru	192
32.	Bagura Oya	92	84.	Mendekal Aru	297
33.	Girikula Oya	15	85.	Pallarayan Aadu	159
34.	Helawa Aru	51	86.	Pali Aru	451
35.	Wila Aru	484	87.	Chappi Aru	66
36.	Heda Oya	604	88.	Parangi Aru	832
37.	Karanda Oya	422	89.	Nay Aru	560
38.	Simena Aru	51	90.	Malvatu Oya	3246
39.	Tandiadi Aru	22	91.	Kal Aru	210
40.	Kangikadichi	56	92.	Moderagam Aru	932
41.	Rufus Kulam	35	93.	Kala Oya	2772
42.	Pannel Oya	184	94.	Moongil Aru	44
43.	Ambalam Oya	115	95.	Mi Oya	1516
44.	Gal Oya	1792	96.	Madurankuli Aru	62
45.	Andella Oya	522	97.	Kalagamuwa Oya	151
46.	Thumpankoni Tank	9	98.	Pantampola Oya	215
47.	Namakada Aru	12	99.	Deduru Oya	2616
48.	Mandipattu	100	100.	Karambala Oya	589
49.	Pattanthe Dephue Aru	100	101.	Ratmal Oya	215
50.	Magalawatavan Aru	346	102.	Maha Oya	1510
51.	Vett Aru	26	103.	Attanagalu Oya	727
52.	Mundeni Aru	1280			

(Fig: 3)

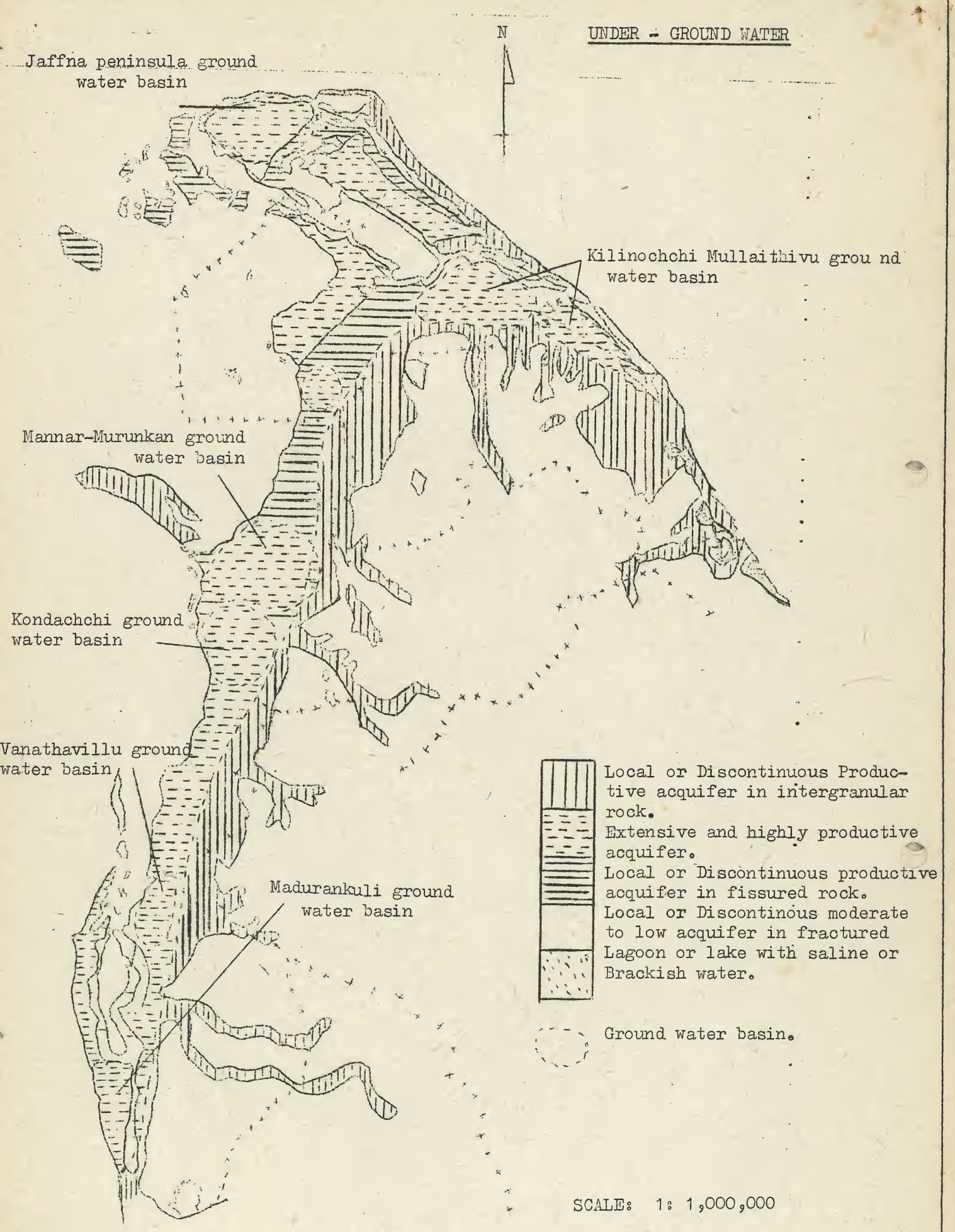

N
UNDER - GROUND WATER
Jaffna peninsula ground water basin
Kilinochchi Mullaithivu grou nd water basin
Mannar-Murunkan ground water basin
Kondachchi ground water basin
Vanathavillu ground water basin
Madurankuli ground water basin
Local or Discontinuous Productive acquifer in intergranular rock.
Extensive and highly productive acquifer.
Local or Discontinuous productive acquifer in fissured rock.
Local or Discontinous moderate to low acquifer in fractured
Lagoon or lake with saline or Brackish water.
Ground water basin.
SCALE: 1: 1,000,000

FIG. 9